REMARKS

Bearing in mind the comments of the Official Action and the telephonic interview between the undersigned and Examiner Maples on November 26, 2001, the application has been amended so as to place it in condition for allowance. An early indication of the same would be appreciated.

Claims 1-7 are pending in this application. Claims 1 and 7 are independent. Claims 1-6 have been amended, and claim 7 has been added by this amendment.

Withdrawal of the rejection of claims 1-6 under 35 U.S.C. § 112, first paragraph, for recitation of the term "electrolyte" is requested. Applicants believe that use of the term "electrolyte" is proper, given the common use of such a term by persons having skill in the art. Enclosed with this amendment is an excerpt from a text on battery technology, which is seen to use this term, and which supports Applicants' contention that this term is enabling to persons with skill in the art.

Notwithstanding Applicants' belief that original claims 1-6 are completely enabled, in an effort to expedite prosecution of the application, and after consultation with the Examiner, the term "electrolyte" has been amended to recite "electrolyte solution", where appropriate, in pending claims 1-6.

Further, as an aid to the Examiner's review, claims 1-6 have also been amended to place these claims in a form customary for U.S. practice. Allowance of claims 1-6 is requested.

Newly presented independent claim 7 has been drafted to avoid the cited (but not applied) art as well as to avoid the basis for the §112 rejection, using alternative claim language. Allowance of claim 7 is also requested.

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In view of the above, consideration and allowance of pending claims 1-7 are, therefore, respectfully solicited.

In the event the Examiner believes an interview might serve to advance the prosecution of this application in any way, the undersigned attorney is available at the telephone number noted below.

The Director is hereby authorized to charge any fees, or credit any overpayment, associated with this communication, including any extension fees, to CBLH Deposit Account No. 22-0185.

Respectfully submitted,

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Enclosures: Claims after Amendment
Excerpt – C.A. Vincent et al.,"Modern Batteries: *An Introduction to Electrochemical Sources*", 2nd Ed. John Wiley, New York, 1997

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MODERN BATTERIES
An Introduction to Electrochemical Power Sources
Second Edition

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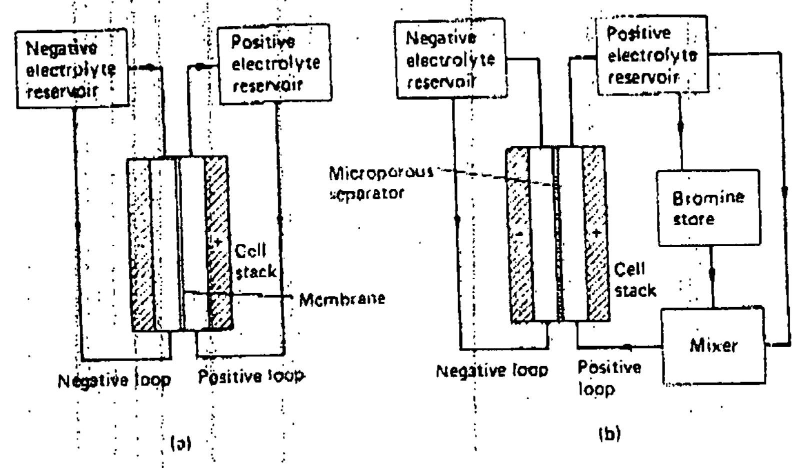

Fig. 9.21 Schematic diagrams of zinc–bromine battery systems: (a) cell with cation selective membrane; (b) cell with reservoir for polybromide and microporous separator

circumstances, bromine is evolved on the negative, and the substrate must be able to withstand this process. In practical batteries this problem is often solved by using bipolar vitreous carbon electrodes.

A particular problem with this cell system is the high rate of self-discharge due to the chemical reaction of bromine with the zinc negative. One solution is to separate anolyte and catholyte by a cation-selective membrane which is impermeable to bromine, such as perfluorosulphonic acid-based materials like 'Nafion', as illustrated in Fig. 9.21(a). An alternative approach is to react the bromine in order to form an insoluble solid or liquid phase. For example, unsymmetric quaternary alkyl ammonium perchlorates react with bromine to form oily polybromides which significantly reduce the level of free bromine in solution. In some designs the insoluble bromine complexes are retained within the porous electrode structure; in more advanced large capacity systems, a separate polybromide reservoir is incorporated (Fig. 9.21b). A simple microporous separator is then sufficient to prevent excessive self-discharge. A typical cell stack is shown schematically in Fig. 9.22. Practical cells now all employ electrolyte circulation to improve the quality of the zinc deposit and to permit the operation of heat exchangers. Note that in both cell configurations shown in Fig. 9.21(a) and (b), twin circulation systems are required. The Austrian company Powercell is currently developing zinc–bromine prototypes for EV use which have a projected energy density of 70–90 Wh/kg and a cycle life of more than 500.

Hydrogen–metal cells

As with the metal–oxygen system, hydrogen–metal cells can be considered as closed galvanic/fuel cell hybrids. They make use of the hydrogen

Claims after Amendment

Please amend claims 1, 2, and 4-6 as follows:

1. (Amended) [Membrane-separated] A membrane-separated, bipolar multicell electrochemical reactor for half-cell reduction and oxidation reactions in respective positive and negative liquid [electrolytes,] electrolyte solutions without gas evolution, [including] said reactor comprising:

a plurality of alternately disposed bipolar plate electrode elements and ion exchange membrane separator elements[,] defining a positive electrolyte solution flow chamber on one side of each membrane and a negative electrolyte solution flow chamber on [the] an opposite side thereof,

said plurality of alternately disposed bipolar plate electrode elements and ion exchange membrane separator elements being sealingly assembled together in a filter-press arrangement between two end electrode elements electrically coupled into an electric circuit [functionally including] which includes an electrical source forcing a current through the electrochemical reactor or an electrical load absorbing a current from the electrochemical reactor,

said bipolar plate electrode elements and said ion exchange membrane separator elements including a frame portion of an electrically nonconductive and chemically resistant material cooperating with sealing gasket means for sealing, and having through holes and recesses in coordinated locations forming, upon [assembling] assembly, ducts for [the] a separate circulation of a negative electrolyte solution and of a positive electrolyte solution, cascadedly in all said negative electrolyte solution flow chambers and in all said positive electrolyte solution flow chambers, respectively,

[characterized in that all the]

wherein each of a plurality of frames of said bipolar plate electrode elements and of said ion exchange membrane separator elements have an inner flange portion[,] recessed from a first planar face of the frame on [the] an opposite side of [the] an other

face of the frame having grooves for accommodating O-ring gaskets around pass-through electrolyte-ducting holes and around an outer seal perimeter, accommodating thereon a perimetral portion of the respective bipolar plate electrode or ion exchange membrane separator;

a plurality of retention pins [project] projecting out of the surface of said flange portion and [pass] passing through holes of said perimetral portion of the plate electrode or membrane separator accommodated thereon;

a retention counterflange of an electrically nonconductive and chemically resistant material having holes coordinated with the positions of said retention pins and functionally mounted over said perimetral portion of said plate electrode or said membrane separator on said recessed flange portion of the frame, and permanently fixed thereon by [hot-flattened] flattened heads of said retention pins protruding out of said coordinated holes of the counterflange; and

pre-assembled bipolar plate electrode elements and membrane separator elements being alternately [stackable in] stacked in a horizontal position with said other face of the frames carrying the O-ring gaskets facing in an upward direction.

2. (Amended) The electrochemical reactor of claim 1, [characterized in that] wherein said other face and said first planar face of each frame portion [are provided with] have a plurality of keying and alignment pins and sockets, respectively, of different shape from each other,

said plurality of keying and alignment pins and sockets preventing the stacking of said bipolar plate electrode elements and [of] said ion exchange membrane separator elements in an incorrect alternate order [and/or] and in an incorrect orientation.

4. (Amended) The electrochemical reactor of claim 1, wherein [the directions] a direction of flow of said negative electrolyte [and] solution opposes a direction of flow of said positive electrolyte solution in respective flow chambers along

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[the] opposite sides of each ion exchange membrane separator[, are opposite to each other].

5. (Amended) The electrochemical reactor of claim 1, wherein each of said bipolar plate [electrode consists of] electrodes comprises a fluid-impervious, electrically conductive plate,

said electrically conductive plate having, on opposite faces thereof, porous fluid-pervious three-dimensional electrode structures [in the form of] including a [felt or fabric] material of carbon fibers bonded in electrical continuity to said electrically conductive plate,

the electrolyte solution entering the electrode chamber along one side and exiting the chamber from [the] an opposite side[; and further characterized in that],

wherein said porous electrode structure has two distinct comb-shaped channelworks, [the]

each of a plurality of finger channels of [one] a source channelwork being substantially parallel to each other and interleaved with [the] a plurality of substantially parallel finger channels of [the other] a drain channelwork; [a]

the [first or] source comb-shaped channelwork having a base [or] manifolding channel running along [the] a side of [the] a chamber through which the electrolyte solution is fed into the chamber, and the [second or] drain channelwork having [its] a base [or] manifolding channel running along [the] an opposite side of the chamber from which the electrolyte solution exits the chamber;

wherein all finger channels of [one] said source channelwork [extending] extend from the respective base [or] manifolding channel and [terminating] terminate short of reaching the manifolding channel of the [other] drain channelwork.

6. (Amended) The electrochemical reactor of claim 1, wherein the ducts for the separate circulation of each of said negative and positive [electrolytes] electrolyte

solutions defined by said through holes across the thickness of each frame portion of said bipolar plate electrode elements and of said ion exchange membrane separator elements are defined by two or more holes spaced along one side of the substantially rectangular frame portion.